

3151-01

What is claimed is:

- 5 1. A method of operating an internal combustion engine, comprising:
introducing an antioxidant composition comprising
 - (A) a sterically hindered phenol;
 - (B) an alkylene or alkylidene coupled sterically hindered phenol oligomer;
 - (C) a secondary aromatic amine;
 - 10 (D) a reaction product of a hydrocarbyl-substituted hydroxy-containing aromatic compound, an aldehyde, and a carboxyl-substituted phenol; or
 - (E) a mixture thereof into a combustion chamber of the engine during the operation of the engine.
- 15 2. The method of claim 1 wherein the antioxidant composition is essentially free of sulfur and phosphorus.
3. The method of claim 1 wherein the antioxidant composition is introduced into the combustion chamber by injection from a dosing system or as a component
20 of a fuel composition.
4. The method of claim 3 wherein the antioxidant composition is present in the fuel composition at 0.1 to 40,000 ppm by weight.
- 25 5. The method of claim 1 wherein the antioxidant composition (A) is a phenol having two or more alkyl substituents that contain 1 to 24 carbon atoms and that occupy the 2-position and 6-position of the phenolic ring.
6. The method of claim 1 wherein the antioxidant composition (B) is a
30 methylene coupled phenol oligomer containing two or more phenolic rings wherein each phenolic ring is occupied at the 2-, 4- and 6-positions by an alkyl or arylalkyl group.

7. The method of claim 1 wherein the antioxidant composition (C) is a diarylamine containing one or more alkyl substituents wherein each substituent contains up to 16 carbon atoms.
- 5 8. The method of claim 1 wherein the antioxidant composition (D) is the reaction product of an alkylphenol, formaldehyde, and salicylic acid.
9. The method of claim 1 wherein the antioxidant further comprises one or more fuel additives.
- 10 10. A method of improving the performance of a lubricating oil of an internal combustion engine by operating the engine according to the method of claim 1.
11. The method of claim 10 wherein the engine is a compression-ignited engine or spark-ignited direct injection engine having an exhaust gas recirculation system.
- 15 12. The method of claim 10 wherein the engine is a compression-ignited or spark-ignited engine having an exhaust treatment device, and the lubricating oil has at least one of the properties selected from the group consisting of a phosphorus content below 0.1% by weight, a sulfur content below 0.5% by weight, and a sulfated ash content below 1.5% by weight.
- 20 13. The method of claim 10 wherein the engine is installed on a motor vehicle and has a recommended drain interval for the lubricating oil of the engine of greater than 6,000 miles.
- 25 14. The method of claim 10 wherein the engine is a stationary engine having a recommended drain interval for the lubricating oil of the engine of greater than 150 operational hours.
- 30 15. The method of claim 10 wherein the engine is a compression-ignited or spark-ignited engine having an exhaust treatment device, and a fuel of a fuel composition used to fuel the engine has a sulfur content below 80 ppm by weight.